Volume 5 Number 4 Fall 2000

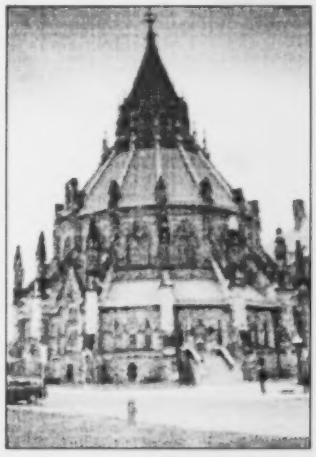
construction innovation

NRC · CNRC

IRC researchers participate in restoration of Parliamentary Library

The Library of Parliament, located immediately behind the Centre Block on Parliament Hill, is a Canadian landmark and one of the best examples of High Victorian Gothic Revival architecture in Canada. Design work for conservation of this beautiful structure is underway and IRC researchers are involved in the process.

The Library, built between 1859 and 1876, is essentially a circular domed structure, supported by a thick masonry wall braced by 16 evenly spaced buttresses. (There is also an outer ring wall, which forms office and storage space beyond the domed central area). The outer surfaces of the walls and buttresses are sandstone blocks of varying sizes bedded in mortar; the cores of the walls are of random rubble construction.



Some of the exterior stone and mortar at locations subject to severe wetting have deteriorated. The exterior sandstone has also partially de-bonded from the core of the wall primarily as a consequence of severe wetting — melting snow from the roof makes areas of the buttresses particularly susceptible. In addition to core sampling, exterior stones were removed over two small sections of the wall to permit visual inspection of the masonry core.

While both core sampling and the removal of stones provide a picture of the interior conditions of the masonry, they cause minor damage to the structure, which in the case of heritage structures is to be avoided if at all possible. Thus to get a more extensive picture of the condition of the masonry while minimizing the impact of the exploration, non-destructive test methods were enlisted.

Following a fire in 1952, major repairs and conservation of the Library were carried out. Today further conservation is required and includes

- installation of a new HVAC system
- addition of a new basement level to house the HVAC equipment
- upgrade of the electrical system and lighting
- upgrades to the windows
- improvements to the layout of the reading room
- restoration of the floors
- installation of a new roof covering
- rehabilitation of the masonry walls and buttresses.

IRC expertise helps

The consultant team responsible for the conservation and upgrading of the Parliamentary Library invited IRC, a known user and innovator of non-destructive test methods, to participate in an evaluation of non-destructive methods for determining the condition of the masonry. In particular, the team was seeking reliable information about the bond of the wall's exterior stones to the core of the wall as an indicator of the Library's structural capacity to withstand the lateral movements (ground motion) of an earthquake.

Two wave propagation techniques, radar and impact echo,

Continued on page 10

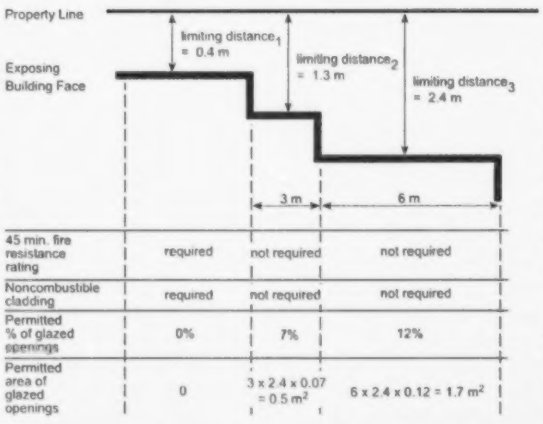
Highlights

Codes "Special Changes"
Energy Codes update
Canada-Russia declaration
PVC railing systems
Hazard assessment tool
Sewer rehabilitation approach

2007-03601/

"Special Changes" to codes approved

The Canadian Commission on Building and Fire Codes (CCBFC) has recently approved Special Changes to the National Building Code (NBC) and the National Plumbing Code (NPC). In some cases, the changes address a safety issue; in others, the changes are aimed at simplifying code requirements by removing a restriction, to reflect advances in technology.



Example of determination of limiting distance from the National Building Code of Canada 1995, Appendix A (Figure A-9.10.14.12.A)

Expansion of the application of Part 5 to building elements exposed to the exterior

A Special Change to the NBC expands the application of Part 5 to all building elements exposed to the exterior — not just those that separate dissimilar environments — including the framed and clad guards used for exterior walkways. This expansion of requirements is intended to improve the design of exterior building elements and consequently reduce the likelihood of premature failure.

Clearances between bare pipes carrying steam or hot water and combustible materials

Another Special Change to the NBC (Part 6) removes a barrier to the use of certain types of insulation. This change affects the requirements for clearances between bare pipes carrying steam or hot water and combustible insulation materials.

Until now, the code required a 15-mm clearance between pipes and surrounding materials. However, it was impossible to conform to this requirement when a wall insulated with a standard insulation product was penetrated by water or steam pipes. In some jurisdictions this requirement was being interpreted such that the use of cellulose fibre insulation was prohibited. Under the Special Change, this requirement does not need to be applied when the temperature of the hot water is less than 95°C.

Spatial separations in buildings covered by Part 9 of the NBC

This Special Change to the NBC addresses a potentially hazardous situation. Part 9 of the code, which applies to houses and various other small buildings, provides two methods for determining limiting distance — that is, in general, the distance a building must be placed from the lot line. This distance depends on the area of unprotected openings in the facade. One approach for establishing limiting distance uses a table of values (see figure above); the other is based on a calculation derived from the square root of the area of unprotected openings.

In the 1995 NBC, a relaxation to the Part 9 requirements in the case of staggered or skewed walls of houses was introduced (see figure). However, it was subsequently found that permitting a relaxation to limiting distances determined by the calculation method could result in an unlimited area of unprotected openings, which was not the intent of the relaxation.

The Special Change rectifies the situation by specifying that the relaxation only applies when the limiting distance is determined using the table.

Contaminant transfer from garages to dwelling units

A Special Change to the NBC (Part 9) related to contaminant transfer from garages to dwelling units addresses a potential safety hazard and provides for a greater level of airtightness between these spaces. This change extends the requirement for airtightness to all assemblies between dwelling units and attached garages, and describes an acceptable solution for achieving the necessary degree of airtightness.

Previously, airtightness was called for only when the separation between a dwelling unit and its garage was not constructed as a fire separation, the assumption being that fire separations were sufficiently airtight. However, this is not necessarily true, and where airtight elements were installed, criteria were not specified to define the degree of airtightness required. In addition, the requirements did not apply to separations between dwelling units and repair garages.

Requirements that affect the possibility of transfer of air contaminants from garages through duct

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Industry involved in training and education for objective-based codes

The Canadian Commission on Building and Fire Codes (CCBFC) has formed a National Steering Committee on Training and Education for Objective-Based Codes, and has invited those involved in training and education related to building and fire codes to participate in this national initiative. The committee's role is to facilitate collaborative action by interested parties in preparing for the launch of objective-based codes.

Even though the new codes will be based on the 1995 national codes, the introduction of objective-based codes will bring important changes that affect code users. These changes include

- the addition of new content related to objectives and functional requirements;
- changes to technical requirements, reflecting the normal process of upgrading requirements in response to technology and regulatory issues; and
- the elimination of some code requirements that do not fit with the agreed-upon code objectives.

Designers, conformance assessment officials and contractors will need guidance in finding their way around the new codes and in understanding how to go about gaining acceptance for "alternate solutions" to requirements.

To achieve a smooth transition to the new codes, "bridging" training and education is required and needs to be put in place well before the provinces and territories adopt the new codes, which is expected to be around mid-2004.

After consulting with the provinces and territories and the various organizations of code users, it was clear to the Commission that there was support for a national initiative. This support will help minimize variation in the understanding and application of the new codes across the country.

The steering committee will make use of the existing code training and education infrastructure and, operating on a collaborative basis, will share information and develop the necessary course content. The bridging courses will then be delivered through existing training and education channels such as technical colleges and architecture schools.

The work of the committee, which represents the interests of architects, engineers, technologists, contractors, code officials, industry associations and vocational institutions, is now underway and will be completed and delivered before 2003.

Other groups of code users with the resources to commit to this effort are also invited to contribute their expertise and content to the committee. If you are interested in participating, please contact Mr. John Archer at (613) 993-5569, fax (613) 952-4040, or e-mail john.archer@nrc.ca.

Newsbrief

Changes to NPC will harmonize venting requirements for plumbing systems in Canada

A task group of the standing committee responsible for the National Plumbing Code (NPC) has recommended changes to the NPC intended to harmonize venting requirements for plumbing systems currently in use in Canada. Harmonization will greatly help the Canadian plumbing industry since mechanical contractors and installers will no longer have to adapt their installations to suit various jurisdictions.

At present, the wording used in Ontario and British Columbia is different from that in the NPC 1995, making it difficult for plumbing contractors from one province to work in another.

The task group, which includes plumbing regulators, code users and instructors, cooperated in redrafting Section 5 of the code. The standing committee has accepted their "harmonized" venting requirement proposal and is now circulating it to stakeholders for informal review and comment.

If you would like to obtain a copy of the proposal, please contact Mr. Raman Chauhan, Technical Advisor, at (613) 993-9633, fax (613) 952-4040, or e-mail raman.chauhan@nrc.ca.

Please note that all comments and concerns for consideration by the standing committee should be submitted to Mr. Chauhan by December 31, 2000.

Raman B. Chauhan, P. Eng.
Technical Advisor
National Research Council of Canada
Canadian Codes Centre
Building M 24
Ottawa, ON K1A 0R6

Please note that the CCBFC meeting scheduled for February 25-26, 2001 has been postponed until September 2001 and that the provincial and territorial deputy ministers meeting scheduled for April 16, 2001 has been postponed until the Fall of 2001.

Update on the national energy codes and related software

NRC·CNRC
Model National Energy Code of Canada for Buildings 1997
NRC·CNRC
Model National Energy Code of Canada for Houses 1997

Acceptance and use of the model national energy codes is growing steadily. Five thousand copies of the codes have already been sold and are being used by building designers, developers and contractors across Canada as the basis for cost-effective, energy-efficient designs for houses and other buildings.

Designers of new buildings in the city of Vancouver and the province of Ontario now have the option of meeting the requirements of the *Model National Energy Code for Buildings* (MNECB) instead of those of ASHRAE 90.1. As well, Vancouver references the *Model National Energy Code for Houses* in its building code. Other provinces are considering how the model energy codes could be used, as part of their commitment to reduce greenhouse gas emissions.

Natural Resources Canada (NRCan) uses the MNECB as the foundation for its successful Commercial Building Incentive Program (CBIP), which is intended to help offset the extra cost of designing energy-efficient buildings. A financial incentive of up to $80,000 will be awarded to building owners whose designs meet CBIP requirements. To date, more than 80 CBIP projects across Canada have been approved.

To qualify for the incentive program, designers use compliance software to show that the energy performance of the proposed design is 25% better than that required by the MNECB.

"Special Changes" to codes approved

Continued from page 2

systems to the dwelling unit have also been revised to better address this issue.

Spacing required to support vertical pipes

The CCBFC has approved a Special Change to the National Plumbing Code that removes an unnecessary restriction on the spacing required to support a vertical pipe made of composite materials such as PE/ALPE and PEX/AL/PEX.

Previously, the composite pipes were required to be supported every 2 metres whereas other types of pipe needed to be supported only every 7.5 metres. However, tests conducted on both composite and other types of pipe have shown that the composite pipes are at least as stiff as the other types. As part of the change, the reference to "metal" rests is also being deleted to make the requirement more generic.

For further information about these changes to the codes, contact: Ms. Adaire Chown (NBC) at (613) 993-0352, fax (613) 952-4040, or e-mail adaire.chown@nrc.ca.

Mr. Raman Chauhan (NPC) at (613) 993-9633, fax (613) 952-4040, or e-mail raman.chauhan@nrc.ca.

The Model National Energy Code for Houses (MNECH) and *Model National Energy Code for Buildings* (MNECB) set out minimum standards of energy efficiency for components and systems in new houses and buildings constructed across Canada. Complementing the National Building Code of Canada (NBC), the MNECB and MNECH identify a cost-effective level of envelope thermal resistance for each region, based on long-term forecasts of regional heating fuel and construction costs.

The MNECB and MNECH code documents can be ordered by calling 1 800 672-7990 or (613) 993-2463 in Ottawa-Hull and U.S., or by visiting the Web site at www.nrc.ca/irc/publications/order.html.

The CBIP EE4 performance compliance software is available free of charge from the CBIP Web site at http://cbip.nrcan.gc.ca.

The four energy code performance and trade-off compliance software programs, EE4 Code, Bildtrad, HOT2^{TM}EC and Houstrad, are also available free of charge at NRCan's Buildings Group Web site at www.buildingsgroup.net.

Russia and Canada sign joint declaration

In June Canada and Russia signed a joint declaration that is intended to increase mutual cooperation and eliminate technical barriers to trade related to construction products and systems.

The declaration paves the way for the Canadian Construction Materials Centre (CCMC) and Canadian certification and testing organizations to be recognized under the Russian product acceptance system for construction products. This should help create favourable conditions for the introduction of modern Canadian technologies to the Russian housing market.

As a result of the declaration, information will be provided on products that are subject to mandatory and voluntary certification according to Russian law. In the case of new and innovative construction products for which no standard or certification program exits, technical approval is required. The document makes clear which Russian organizations require mandatory or voluntary certification for a specific product and under what circumstances technical approvals are required.

In order to reduce the cost and time of certification and approval procedures, the delegations have agreed to meet regarding the coordination of testing methods. Russian organizations will also cooperate in granting accreditation to Canadian organizations, recognizing their test results for purposes of product certification and technical approval.

All signing agencies will actively promote the process outlined in the declaration and provide support to Canadian manufacturers who want to export to Russia by making them aware of the process and how it works.

The declaration will be in effect for a minimum of five years.

Specific questions can be directed to Mr. Luc Cécire at (613) 993-0776, fax (613) 952-0268, or e-mail luc.cecire@nrc.ca.

The Canadian signatories to the declaration were Canada Mortgage and Housing Corporation (CMHC), National Research Council of Canada (NRC), and Underwriters' Laboratories of Canada (ULC).

Russian parties involved in the signing were the Russian Federation State Committee on Construction and Housing (Gosstroy Russia); Russian Federation State Committee on Standardization and Metrology (Gosstandart Russia); and the Russian Federation Ministry of Internal Affairs Principal Directorate of National Firefighting Services (MIA Russia PD NFS).

The official version of CCMC's Registry of Product Evaluations can now be found on CCMC's Web site at http://www.nrc.ca/ccmc/home_E.shtml.

The on-line Registry is updated quarterly.

Effective October 1, 2000, the print version will only be published annually.

New product evaluations

CCMC is pleased to announce the following new product evaluations that have been completed between 29 June 2000 and 30 October 2000. Due to predetermined publication schedules, these evaluations may or may not appear in the Summer 2000 issue of the Registry of Product Evaluations.

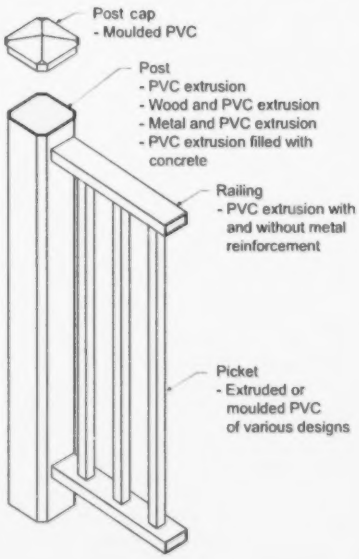
Manufacturer	Name of Product	Type of Product	Eval No.
Domco, Division de Domco Tarkett Inc.	Rustic®	Sheet Vinyl Floor Covering with Backing	12985L
Dominion Plastics Inc.	Series 469-470 Fixed Casement Window	Fixed Vinyl Windows	12975L
Dominion Plastics Inc.	Series 469-470 Picture Window	Fixed Vinyl Windows	12976L
Farley Windows, Inc.	Series 340 Tilt Slider	Tilt and Turn Vinyl Windows	12983L
Inde Pane Ltd.	Dusco Door	Insulated Steel Door Slab	12937L
Laflamme Portes & Fenêtres Inc.	Maxima	Casement/Awning/Hopper Vinyl Windows	12979L
Les Produits Isolofoam Inc.	Isoclad	Composite Insulation	12980R
Les Produits Isolofoam Inc.	Isoclad - Air Barrier Material	Air Barrier Materials	12981R
Roxul Inc.	High Density Batts (H.D. Batts)	Preformed Mineral-Fibre Insulation Board	12977L

CCMC evaluates PVC railing systems

Today, an increasing number of PVC railing systems are being sold at local building materials suppliers. These systems are being used in place of traditional wood railings to build balconies and decks for houses. PVC railings take many different forms — some are basically wood railing clad with PVC, others are made of a combination of PVC extrusions and mouldings, cold-formed steel elements and aluminum extrusions. But there is some question as to whether these systems conform to the requirements of applicable building codes.

Because railing systems play a structural role, they must be capable of resisting the loads they are likely to be subject to under normal conditions. They must also be able to maintain their structural capacity under the environmental conditions they are exposed to over time, including ultraviolet rays, high and low temperatures, and water and salt.

Railing systems made of structural materials, such as wood and steel, can be designed to resist applicable loads on the basis of known material properties and established calculation procedures. However, for systems that are made



A typical PVC railing system

of non-traditional materials, such as PVC, or that use accessories without established physical and mechanical properties, no such procedures exist. Thus these systems and their components must be tested to demonstrate that they meet applicable code requirements, which means that there must be recognized test procedures and pass/fail criteria that take the characteristics of each product into consideration.

To this end, CCMC has developed a Technical Guide for the evaluation of PVC railing systems. The Guide includes evaluation requirements related to the physical properties and durability of PVC extrusions, the structural performance of the system, and its anchorage. At the moment, the Technical Guide does not address all possible physical and mechanical characteristics of each and every proprietary railing system. It is modified as needed on a case-by-case basis to address the performance of each component of the system being evaluated by CCMC.

Recently, several manufacturers of PVC railing systems have expressed an interest in creating a consortium to develop a benchmark protocol in a revised Technical Guide. Others interested in joining such a consortium should contact CCMC.

Enquiries about evaluations and other questions can be directed to Mr. Gilles Poirier at (613) 993-6623, fax (613) 952-0268, or e-mail gilles.poirier@nrc.ca.

Evaluation of structural fire performance of unprotected assemblies for houses

After an extensive review process, CCMC has concluded that the structural fire performance of unprotected wall and floor assemblies used in houses cannot be evaluated using standard fire resistance tests.

At present, the National Building Code of Canada 1995 (NBC) prescribes the materials and assemblies (based on conventional wood-frame construction) that are permitted for a particular end use in houses and small buildings. The code also contains an "equivalency" clause, which allows for the use of alternative products for a specific end use (e.g., floor joist, wall stud or foundation wall) if it can be demonstrated through testing or analysis that their performance is equivalent to that intended by the code.

A dilemma arises, however, when alternatives to conventional wood-frame construction (floors, exterior walls and basement walls) are proposed, since explicit requirements for the structural performance of houses in fires are not provided in the code. This raises the question: What is the minimum structural fire performance that will ensure safe occupant evacuation?

CCMC is continually faced with this dilemma when it is asked to evaluate new products such as engineered wood products, steel framing, foam plastic composites, modified-cementitious composites,

Continued on page 7

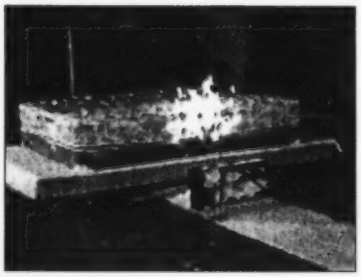
Fire researchers use new tool for hazard assessment

Fire researchers at IRC are using an FTIR (Fourier Transform Infrared) spectrometer to obtain data on smoke components for use in hazard assessment. FTIR has become an important tool in the IRC arsenal for understanding the impact of different materials in fires on building occupants.

Traditionally, smoke gas analysis has focused on the measurement of oxygen, carbon dioxide (CO_2) and carbon monoxide (CO). By measuring carbon monoxide, the quantity of the main toxic component produced in a fire could be determined and used along with smoke obscuration measurements to make assessments of occupants' ability to move through a space and maintain mobility for purposes of evacuation. Other combustion by-products, if measured at all, were determined using standard analytical chemistry techniques, including gas chromatrography and mass spectrometry.

These traditional techniques have a number of limitations — in particular, they are time consuming and do not allow for the continuous monitoring of selected fire gas components. Also, many fire gases are very reactive so that they break down or react in the storage system, making it difficult to obtain representative samples and to have confidence in the results.

Today, with the increasing use of synthetic polymers, composites and flame-retardants in building materials and consumer goods, there is a greater need to be able to measure a broad range of combustion by-products, in order to assess any hazards they might pose. The FTIR spectrometric technique has definite advantages over previous methods, as it is able to provide continuous monitoring of secondary gases such as hydrogen cyanide, hydrogen halides, methane, ethylene and acetylene, as well as CO and CO_2, which is not possible with more traditional methods.



Using the FTIR technique to analyze smoke from a burning mattress

In this technique, an infrared light source shines through a gas sample and the absorption of infrared light over a range of wavelengths is determined. (Each molecule has specific wavelengths at which it will absorb the infrared light.) Calibration procedures are used to determine the concentration of selected components.

IRC has successfully linked the FTIR concept to its full-scale fire-testing program, which in many cases simulates real-fire scenarios in residential, retail and office environments and includes tests with clothing, toys, furniture such as sofas and beds, and computer cable. Specifically, carbon monoxide and carbon dioxide concentrations measured using the FTIR technique are comparable to those measured with traditional gas analyzers in full-scale fire tests. As well, the FTIR data yielded additional information on many other combustion by-products, providing further insight into the dynamics of fires.

Specific questions can be directed to Dr. Malgosia Kanabus-Kaminska at (613) 993-6302, fax (613) 954-0483, or e-mail malgosia.kanabus-kaminska@nrc.ca.

Evaluation of structural fire performance

Continued from page 6

and cardboard-based constructions, intended for use in floors, exterior walls and basement walls. Local authorities also face the same dilemma when considering whether or not to approve these new products.

Both the Canadian Commission on Construction Materials Evaluation (CCCME) and the Canadian Commission on Building and Fire Codes (CCBFC) have discussed the need to address this issue. Following these discussions, IRC suggested that standard fire-resistance tests be conducted to establish benchmarks for the structural performance of floors, exterior walls and basement walls used in conventional wood-frame house construction, with the intent of providing a basis for determining equivalency of innovative structural products. But this approach was found wanting because standard fire-resistance tests were developed for assessing protected assemblies, not exposed assemblies.

IRC has concluded that a more comprehensive research project is needed to develop a framework within which the full range of fire-safety issues for dwelling units can be addressed. The Fire Risk Management Program will refocus its strategic research activities so that the factors that affect fire performance and life safety for Canadian homes can be determined.

CCMC will continue to assess the possible implications of this research for its product evaluations. However, until the framework is completed, CCMC evaluations will not address the issue of structural fire performance in houses.

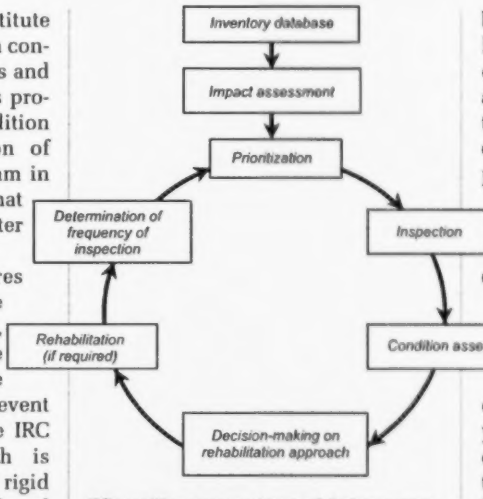
Specific questions can be directed to Mr. Bruno Di Lenardo at (613) 993-7769, fax (613) 952-0268, or e-mail bruno.di_lenardo@nrc.ca.

Collaborative effort produces decision-making approach for sewer rehabilitation

A collaborative effort by the Institute for Research in Construction, in conjunction with 10 municipalities and two consulting companies, has produced a new approach to condition assessment and rehabilitation of large sewers (more than 900 mm in diameter) and access holes that will help municipalities better manage their assets.

Large sewer structures require special attention since they are usually buried deep, without any redundancy in the system, which means that the consequences of failure in the event of collapse can be great. The IRC assessment approach, which is applicable to both flexible and rigid pipes, is systematic (see figure) and looks beyond the identification and coding of defects to the condition of the structure, its importance to the system and the requirements for its rehabilitation. The unified coding and assessment system will enable municipalities across the country to share information.

The first step in the process is to compile an inventory database of all pipes. Next, an impact assessment for both pipes and access holes is carried out. Since not all pipe segments have the same probability or consequence of failure, an impact rating system was created. This involves considering factors such as location, type of soil in which the pipe is embedded, pipe size, burial depth, sewer function and seismic zone. Each factor is evaluated, rated and combined in a weighted formula to give an overall impact rating for a segment of pipe. The ratings for all pipe segments can be placed on a map of the sewer system for easy identification of "hot spots."



IRC's condition assessment approach for large sewers and access holes

From the impact assessment with its impact rating, municipalities can determine which pipes or access holes are most likely to cause problems, and can then prioritize segments for inspection purposes. Inspection data are derived from various methods such as closed circuit television (CCTV), person entry, in-situ strength testing, joint testing, rotary sonic device, or diver.

In the course of the inspection, defects are found, identified and coded. The IRC approach provides definitions for identifying and rating defects on the basis of type and degree of severity. There are two main types of defect — service (i.e., grease build-up, roots, infiltration) and structural (i.e., fractures, open joints and broken pipes) — and up to three levels of severity. For structural defects, factors such as the length and depth of the defect are weighted to give a structural rating; in the case of service defects, factors such as the percentage of the cross-section that remains open govern the service rating of a pipe segment.

The condition assessment, comprised of the impact rating, the structural rating and the service rating, is the basis for making decisions about the approach to rehabilitation — do it now, do it within the next five years, or leave it alone. Once the decisions on rehabilitation and on the required frequency of inspection have been made, the pipe or access hole is "returned to the database" until its next scheduled inspection.

If you have specific questions or would like information about the guideline document on IRC's condition assessment approach, please contact Ms. Shelley McDonald at (613) 993-3336, fax (613) 954-5984, or e-mail shelley.mcdonald@nrc.ca.

This project was sponsored by

Capital Regional District, Victoria, BC
City of Calgary, Calgary, AB
City of Edmonton, Edmonton, AB
City of Regina, Regina, SK
City of Toronto, Toronto, ON
City of Waterloo, Waterloo, ON
Greater Vancouver Regional District, Burnaby, BC
Region of Hamilton-Wentworth, Hamilton, ON
Region of Ottawa-Carleton, Ottawa, ON
R.V. Anderson Associates, Ltd., Willowdale, ON
M.E. Andrews & Associates, Ltd., Ottawa, ON

New software will help municipalities plan for water main renewal

IRC is planning to organize a consortium of water utilities to develop a new tool that will help municipalities decide how and when to renew water mains, thereby facilitating their capital planning.

Effective planning for the renewal of water distribution systems requires accurate quantification of the structural deterioration of water mains. As typical water distribution systems comprise hundreds and even thousands of buried pipes, direct inspection of all of them is prohibitively expensive. Identifying water main breakage patterns over time is an effective and inexpensive alternative to measuring the actual deterioration in a water distribution system.

Several deterministic and statistical models are available in the literature for analyzing water main breakage patterns and forecasting both short- and long-term repair and renewal needs. These models require different types of input for which data may or may not exist. IRC researchers are taking some of these theoretical models and converting them into a tool that provides a framework for making decisions. The prototype tool being developed by IRC is known as **WARP** (Water Mains Renewal Planner). It consists of three separate modules, which can be described as follows:

1) Analysis of water main breakage patterns

The analysis of breakage patterns considers time-dependent factors such as temperature, soil moisture (rainfall deficit) as well as rates of main replacement and retrofitting with cathodic protection. The influence of each of these factors can be quantified to identify deterioration rates of buried water mains as a result of normal ageing.

2) Short-term operational forecasting

The short-term forecast is conducted in two steps. The first step is to obtain monthly forecasts for temperature and rainfall from an analysis of historical data. Alternatively, forecasts can be obtained from climate centres that study weather dynamics. Although both types of forecast have their limitations, they provide guidance on short-term expectations. The second step involves forecasting the breakage pattern of mains for the next two years using the failure patterns identified in the first module in conjunction with the climate information derived from step one of this (second) module.

3) Long-term renewal planning

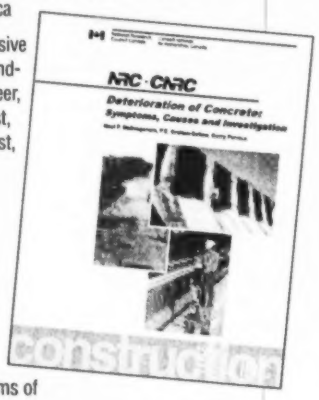
The long-term renewal planning module uses the ageing rate identified in the first module to determine the survival rate (and hence the replacement rate) of water mains in the system. **WARP** allows the user to compare various patterns of ageing and to select the most appropriate one on which to base the long-term replacement strategy. Capital investment needs as well as repair budgets can then be projected. **WARP** will also allow users to make financial projections based on user-defined replacement scenarios.

The three modules have been implemented in a prototype software. A fourth module, which allows users to set priorities for the renewal/replacement of individual water mains, will be incorporated later. The modules will work independently or as a single, seamless decision-making engine within existing geographical information systems (GIS) or other database management systems.

Utilities and others interested in participating in the development of such decision-making tools are encouraged to call Dr. Balvant Rajani at (613) 993-3810, fax (613) 993-3142, or e-mail balvant.rajani@nrc.ca. Participants will be expected to provide modest financial support as well as in-kind contribution, and to review and provide feedback for the various stages of development of the software tools.

Deterioration of Concrete: Symptoms, Causes and Investigation

By Noel P. Mailvaganam, P.E. Grattan-Bellew and Gerry Pernica



This comprehensive publication, intended for the engineer, specifier, chemist, materials scientist, and architect discusses

- causes of concrete durability problems
- types of structures affected and the mechanisms of deterioration
- methods of investigating defects
- methods of evaluating structures.

90 pages, including 45 photos and illustrations and 9 tables. Order Number NRCC 44494. $40.

To order, please call IRC Publication Sales at 1 800 672-7990 or (613) 993-2463 (Ottawa-Hull and U.S.)

Building envelope and structure

IRC researchers participate in restoration of Parliamentary Library

Continued from cover page

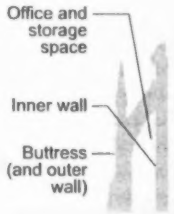
were selected for the task. Radar (an electromagnetic method), however, gave inconclusive results — the large number of waves that reflected back to the surface from the myriad of interfaces of the stone and mortar were difficult to interpret. Impact echo (an acoustic method), which uses hammer impacts to produce sonic stress waves, provided information that was more meaningful.

To deal with the particular problems posed by the thick masonry construction, IRC researchers improved the test procedure for the impact-echo method to increase the likelihood of obtaining useful information. This procedure relies on the proper selection of impact location, impact hammers and hammer-specific parameters to record and analyze the reflected waveforms induced by hammer impacts on the masonry. Tests conducted over sections of the walls and buttresses have given an indication of

- the thickness of the exterior stone blocks (average range 15-30 cm) and degree of bond to the core;
- the existence of voids or cracks within the masonry;
- the overall condition of the wall or buttress.

This information will assist the consultant team plan the conservation and upgrade of the masonry walls of the Library, without the need for further core sampling or removal of masonry.

Specific questions can be directed to Dr. Gerry Pernica at (613) 993-9750, fax (613) 952-8102, or e-mail gerry.pernica@nrc.ca.



Section through Library of Parliament showing inner and outer walls and buttresses
Drawing courtesy Spencer R. Higgins, Architect Incorporated

The conservation and upgrade of the Library of Parliament is being directed and managed by the Parliamentary Precinct Directorate of Public Works and Government Services Canada.

IRC is part of the consultant team led by Ogilvie and Hogg, Desnoyers Mercure et associés, Spencer R. Higgins and Lundholm Associates, Architects in Joint Venture.

The International Conference on Building Envelope Systems and Technologies (ICBEST)

covering all aspects of the building envelope will be held in Canada for the first time next June.

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Institute for Research in Construction
The International Conference on Building Envelope Systems and Technologies – 2001
National Research Council Canada
Ottawa, Ontario K1A 0R6

New program aims to reduce total construction time by 50 percent

As part of our efforts to keep our readers informed about new construction technologies and practices in other parts of the world, we bring to your attention an interesting European project that is looking at ways of improving project delivery. Some of the approaches identified as promising for the European construction industry may not be applicable to the Canadian industry due to differences in construction techniques and the regulatory framework.

Hollandsche Beton Groep (HBG), an international construction group, together with TNO, Holland's main government research organization, have teamed together in an innovative effort aimed at developing time-saving methods for the construction sector. This initiative, the "HalfTime" project, is focusing on four areas that could benefit from time-saving approaches: construction process, construction products, information technology, and unusual solutions.

In the "process" area, an innovative cooperative system adopted by the off-shore oil industry is being investigated as a possible alternative to traditional construction industry practices. In this novel approach, the main contractor, the consultants and the client participate as one legal entity, with all parties sharing profit and loss and working towards the same goal.

In another component of the HalfTime project, the construction process is being modelled on the system currently used by the automotive and other manufacturing industries. This system is based on resource planning and a continuous mode of production. Preliminary indications suggest that this continuity can result in a reduction of almost 80 percent in the total time needed to build a house.

The group is also looking at new construction products and techniques, including concrete heated in formwork to speed up hardening, and self-compacting concrete to eliminate the need for manual compaction.

Finally, 3D-CAD (three-dimensional computer-aided design) and 4D-CAD, which combines 3D-CAD with the fourth dimension — time, are being investigated as a replacement for traditional two-dimensional drawings. This design approach, which has been used in the aircraft industry for over 10 years, will allow for visualization of the project at any given moment during construction.

While the HalfTime project is not yet complete, indications are that it is possible to reduce total process time through new innovative approaches, at least in the European context.

Symposium focuses on sustainability in building design

A recent symposium sponsored by the Building Environment and Thermal Envelope Council (BETEC) and held in Washington, DC, focused on the issue of sustainability in the built environment. The Sustainable Building Symposium, attended by more than 200 architects, engineers, manufacturers, contractors and academics, covered diverse topics ranging from research on materials and systems to examples of sustainable construction in different parts of the world.

Participants discussed the environmental characteristics of available building envelope materials and examined a number of new "green" materials. In particular, they expressed interest in the use of natural materials (mostly cellulose fibres) to make composites for a wide range of construction applications. Researchers from MIT and the University of Waterloo made presentations on their explorations of the potential of some of these materials.

The symposium also put considerable emphasis on approaches for improving the energy and resource efficiency of buildings, with presentations on

- the sustainability of spray-polyurethane-foam applications in the building envelope
- the potential of cast earth as an energy-efficient building material
- the first North American study to quantify the thermal performance of rooftop gardens through measurements and modelling (see *Construction Innovation*, Volume 5, Number 1, Winter 2000).

Other presentations on design, construction techniques and materials used in environmentally friendly buildings in different parts of the world paid close attention to local needs and culture, the availability of building materials and skilled labour, and cost effectiveness.

Acknowledging the increasing use of computer technology to promote sustainable building design, researchers from the University of Minnesota presented an Internet-based design guide containing 50 different strategies organized according to environmental topics such as water, energy, materials and waste. This guide can be downloaded free of charge at www.sustainabledesignguide.umn.edu.

As well, a new version of Building for Environmental and Economic Sustainability (BEES) software was presented by NIST. BEES is a free software tool that can help building designers select cost-effective green building products. BEES 2.0 can be downloaded at www.bfrl.nist.gov/oae/bees.html.

More details on the symposium are available at the BETEC Web site: http://www.nibs.org/Spring00.PDF.

NRC sponsors a new best practices exchange program

To be competitive in today's global marketplace, it is becoming increasingly important for companies of all sizes, in all sectors, to ensure they have access to, and make best use of, the latest technological developments and management best practices.

Innovation Insights ('ii'), a program sponsored by NRC•IRAP (Industrial Research Assistance Program) and Canadian Manufacturers & Exporters (CME), is designed to help small- and medium-sized enterprises in all sectors meet the challenges they face by providing senior operations people with exclusive access to leading-edge companies. At 'ii' events, visitors can learn about their host company's best practices, and experience the techniques and concepts that have helped it improve profitability, competitiveness and business leadership.

At each Innovation Insights event, the host makes a presentation on the company's background and on the best-practice issues that will be discussed and demonstrated during the course of the day. A tour of the facility follows, with shop-floor staff presentations, giving visitors a chance to talk to employees and find out how the theory matches the reality. The interaction throughout the event allows visitors to learn from their host and from each other, and enables the host to gain useful feedback as well.

All Innovation Insights events include a lunch, providing an opportunity to network with peers and talk with the presentation team on a one-to-one basis.

For more information about host companies in the construction or other sectors, visit www.tvp-ii.org to view the 'ii' program catalogue, or call the 'ii' team to receive your copy by mail: 1 800 999-4129 ext. 231.

Please note that events are limited to 15 participants. The cost to attend an 'ii' event is $100/person/event, networking lunch included.

Upcoming events

2001

JANUARY

5

National Steering Committee on Training and Education for Objective-Based Codes. Ottawa. Contact: Madeline McBride at (613) 993-0045, madeline.mcbride@nrc.ca

7-11

Transportation Research Board 80th Annual Meeting. Washington, DC. (202) 334-3472, fax (202) 334-2299, Web site: http://www.national-academies.org/trb/meeting

15-16

Standing Committee on Building and Plumbing Services. Ottawa. Contact: Raman Chauhan at (613) 993-9633, raman.chauhan@nrc.ca

FEBRUARY

19-21

Standing Committee on Fire Safety and Occupancy. Victoria. Contact: Alastair Aikman at (613) 993-9632, alastair.aikman@nrc.ca

22-23

8th Canadian Conference on Building Science and Technology. Toronto. Contact: Anna Prioste at 1 877 235-6232 (toll free), e-mail: jfstraube@uwaterloo.ca

MARCH

12-13

Joint CCBFC/PTCBS Task Group on the Implementation of the New Code Development System. Calgary. Contact: Richard Desserud at (613) 993-0046, richard.desserud@nrc.ca

12-14

International RILEM Conference on Early Age Cracking in Cementitious Systems. Haifa, Israel. 972-4-8292242/3, fax 972-4-8324534, e-mail: eac@tx.technion.ac.il, Web site: http://tx.technion.ac.il/~eac

25-30

ACI Spring Convention. Philadelphia. ACI Member Services. (248) 848-3800, e-mail: member-services@aci-int.org, Web site: http://www.aci-int.net/index.htm

28-30

Fourth International Conference on Water Pipeline Systems — Managing Pipeline Assets in an Evolving Market. York, UK. E-mail: lbrooker@bhrgroup.com, Web site: http://www.bhrgroup.co.uk/confsite/index.html

MAY

2-4

Provincial/Territorial Committee on Building Standards. Victoria. Contact: John Archer at (613) 993-5569, john.archer@nrc.ca

JUNE

6-7

Strategies for Innovation in Construction. Ottawa. E-mail: chris.norris@nrc.ca

10-13

2001 International Conference on Underground Infrastructure Research – Municipal, Industrial and Environmental Applications. Kitchener. Hosted by the Centre for Advancement of Trenchless Technologies, University of Waterloo, and the National Research Council of Canada. E-mail: uir2001@sunburn.uwaterloo.ca, Web site: http://www.civil.uwaterloo.ca/uir2001

construction *innovation*

Construction Innovation is published quarterly by the NRC's Institute for Research in Construction.

ISSN 1203-2743

Editor: Jane Swartz

Institute for Research in Construction
National Research Council Canada
Ottawa, Ontario K1A 0R6

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